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Northern Goshawk

The northern goshawk is a pandemic species found across North America and Eurasia. While named for its nobility it is revered for its ferocity. Attila the Hun wore an image of a northern goshawk on his helmet to scare his enemies. This reflects the goshawks habit of commonly attacking people and other animals that approach their nests too closely.

Habitat characteristics:

The Kaibab Plateau holds one of the most concentrated populations of goshawks known in North America. The northern goshawk is classified as a Forest Service Sensitive species and is a Management Indicator Species (MIS) for the KNF, selected to represent species using late-seral, ponderosa pine (*Pinus ponderosa*) habitat. Goshawks occupy nearly every forest and woodland habitat type that occurs within the hawk's geographic range. In the west, goshawk populations occupy multiple forest types including Douglas fir (*Pseudotsuga menziesii*), various pines, and aspen (Reynolds et al. 1982, Younk and Bechard 1994, Siders and Kennedy 1996, Squires and Ruggiero 1996). In the southwestern United States, this species is primarily found in ponderosa pine forests (Erickson 1987, Reynolds et al. 1994).

Northern goshawks are considered partial migrants (Berthold 1993, Reynolds et al. 1994, Squires and Ruggiero 1995) and migrate during winter in respond to food availability on breeding grounds (Squires and Reynolds 1997). Some goshawk populations exhibit short winter movements to lower elevations or to more open habitat types (Squires and Reynolds 1997). Also, irruptions of adults and juveniles from the breeding range during winter have been documented with adults often returning to breed after such movements (Campbell et al. 1990). While on their breeding grounds, goshawks are territorial and defend the area around their nests, but pairs may overlap in other areas of their home range. Overall, home range can vary from 570–3,500 ha (1,408.5 – 8,648.7 ac), depending on sex and habitat characteristics (Squires and

Reynolds 1997). Defended core areas, including the nest, are approximately 32% of home range area (Kennedy et al. 1994). Male home ranges are usually larger than the female's home range (Hargis et al. 1994, Kennedy et al. 1994). In Arizona, male home ranges averaged 1,758 ha ± 500 SD (4344.1 ± 1235.5 ac, Bright-Smith and Mannan 1994) and the average distance between neighboring nests was 3.0 km ± 0.83 SD (1.86 ± 0.52 mi, Reynolds et al. 1994).

Descriptions of forests and woodlands used for breeding by goshawks show great variation in horizontal and vertical vegetation structure and where many of the areas do not produce closed forests with tall trees and continuous canopies that is purported to be required by the birds (Franklin and Dyrness 1973, Eyre 1980, Brown 1982, Barbour and Billings 1988). Thus, the old growth or late seral habitat type that this species is chosen for as a MIS is not necessarily the species preferred habitat type. Instead, it may be just one of many versions of forest types that fit into the broader structural context of its preferred breeding habitat. However, despite the wide diversity of habitats occupied by goshawks, within a habitat type, goshawk nest areas are consistently comprised of mature and older forests (Thomas et al. 1988, Habeck 1988, Bolgiano 1989, Hunter 1989, Franklin and Spies 1991, Kaufmann et al. 1992). These mature and older forests include, but are not limited to, old growth, and are typically concentrated within 30 acres surrounding the nest (Reynolds 2005). Typically, nest areas are composed of large, dense trees, closed canopies created by a variety of tree sizes, and open understories, but exact structure depends on forest type, elevation, and growth site potential (Bartelt 1974, Reynolds et al. 1982, Moore and Henny 1983, Hall 1984, Spieser and Bosakowski 1987, Lang 1994, Siders and Kennedy 1994, Daw 1996, Siders and Kennedy 1996, Squires and Ruggiero 1996, Desimone 1997, Daw et al. 1998, Keane 1999, Finn et al. 2002b).

In Arizona, Crocker-Bedford and Chaney (1988) reported goshawks nested in ponderosa pine stands with > 70% canopy cover, but Lang (1994) found pairs occupying territories with 31-33% canopy cover. Although variable, habitat structure is more important than composition in the nest area (Reynolds 1983, Erickson 1987, Reynolds et al. 1992, Rissler 1995). Nests are built in coniferous or deciduous trees (Bent 1937, Reynolds et al. 1982), but western populations typically use conifers such as ponderosa pine, Douglas fir, white fir (*Abies concolor*), California red fir (*Abies magnifica*), western larch (*Larix occidentalis*), western hemlock (*Tsuga heterophylla*), and lodgepole pine (*Pinus contorta*, Reynolds et al.

1982, Moore and Henny 1983, Squires and Ruggiero 1996) although some deciduous trees are used such as aspen (Doyle and Smith 1994, Younk and Bechard 1994, Squires and Ruggiero 1996). In the southwest, goshawks use ponderosa pine extensively (Reynolds et al. 1992). Goshawks construct stick nests in the lower third of the largest tree available (Reynolds et al. 1982, Speiser and Bosakowski 1987, Hargis et al. 1994, Squires and Ruggiero 1996). Nest height significantly correlated with nest-tree height (Kennedy 1988), thus tree size and structure may be more important than tree species.

Overall, goshawks are closely tied to prey resources and less so to forest habitat type. If there is ample prey available in or adjacent to areas with preferred nesting structure, goshawks will nest regardless if the habitat type is forests, woodlands, or shrub lands (Swem and Adams 1992, Younk and Bechard 1992, 1994). Goshawks like to forage in habitat with relatively open understories so they can easily see and pursue their prey, or use open forest habitats because they can hunt from perch trees for rabbits or ground squirrels in openings between trees (Younk and Bechard 1992, 1994). The variety of foraging habitat lends to the variety of prey items taken. In general, goshawks primarily eat medium-sized birds (e.g., woodpeckers and jays) and small mammals (e.g., squirrels and rabbits, Reynolds et al. 1992).

Because adult northern goshawks are territorial they are, by nature, not a social bird. Not only are goshawks territorial against their own species, but also other raptors while on their breeding range and will readily kill neighboring raptors (Beebe 1974, Kostrzewa 1991). Adults actively defend their nests and have been known to attack red-tailed hawks (*Buteo jamaicensis*;, Crannell and DeStefano 1992), short-eared owls (*Asio flammeus*; Lindberg 1977), and great-horned owls (*Bubo virginianus*, Squires and Reynolds 1997). They are solitary outside the breeding season, but fledglings remain together near the nest until dispersal (Reynolds and Wight 1978, Kenward et al. 1993, Squires and Reynolds 1997). The ferocity of goshawks is likely why the species had few natural predators. However, greathorned owls have been documented killing adults and nestlings (Moore and Henny 1983, Rohner and Doyle 1992, Boal and Mannan 1994, Woodbridge and Detrich 1994). Loss of nestlings to predation may increase when other prey resources are low (Zachel 1985, Rohner and Doyle 1992). Nestlings have been killed by wolverines (Doyle 1995) and one-half of nestling mortalities in New Mexico were attributed to predation (Ward and Kennedy 1996). During the winter, eagles (Squires and Ruggiero 1995) and martens (Paragi and Wholecheese 1994) have been documented taking goshawks.

Potential Management Impacts:

The northern goshawk is considered a Sensitive Species in the Southwest by the U.S. Forest Service (Squires and Reynolds 1997). Sensitive Species designation requires biological evaluations to consider potential impacts of proposed management actions. Goshawks are also considered Management Indicator Species because they are potentially sensitive to habitat change. However, as indicated above, the old-growth habitat they often represent is misleading because the species will use multiple habitat types as long as there is enough mature to old growth forest structure within the general forest.

In the Southwest, management over the past one hundred years has greatly altered forest structure and composition. Historical and current conditions differ considerably in that trees are much denser and in younger age classes. The resulting canopy closure reduces plant species abundance, understory composition is altered, and higher fuel loads currently exist. These habitat conditions can result in the loss of goshawk habitat through high-severity wildfire and epidemic infestation of insects and diseases (Reynolds et al. 1992). Because timber harvest has traditionally been the primary threat to northern goshawks and because the Forest uses the goshawk guidelines for timber management, this management impact will be the focus of this discussion.

Many forms of timber management have been identified as primary threats to nesting goshawk populations (Reynolds 1989, Crocker-Bedford 1990). Nests can be destroyed outright and drastic canopy closure reductions can effectively remove nesting habitat (Bright-Smith and Mannan 1994, Beier and Drennan 1997). These risks are addressed on the KNF by conducting pre-harvest goshawk surveys, avoiding known nest sites, and providing for multiple alternate nests. Research has documented that northern goshawks continue to occupy and breed successfully in the managed areas of the NKRD. Virtually no part of the NKRD contains forests in which tree harvest has not occurred (Burnett 1991, KNF 1993). Reynolds et al. (1994) and Reich et al. (2004) studied breeding goshawks on over 100 territories that produced over 600 young between 1991 and 2003 on the NKRD. This high density of goshawks and their reproduction strongly suggests that goshawks are not old growth obligates in the Southwest.

Past forest management has veered far from the historic range of variation. Reintroducing fire is key to creating sustainable forests in our fire dependent ecosystems and this can only be

accomplished through active management. Reynolds et al. (1992) developed management recommendations for nesting goshawks in the southwestern United States. These recommendations describe desired forest conditions for nesting and foraging habitat while emphasizing conditions that support diverse prey populations. Recommendations prescribe habitat conditions at 3 spatial scales including nesting, postfledgling areas, and foraging areas. Overall, thinning under the goshawk guidelines results in a mosaic of vegetative structural stages interspersed across the landscape. To meet this end, the Kaibab Forest Plan prescribes the following leave percentages for each of 6 tree size-classes. First, because large trees are a critical nesting component, 40% of the trees across the landscape will be greater than 18 inches dbh (Vegetation Structural Stage [VSS] 5 and 6). These large trees will occur as small patches scattered throughout the landscape. The remainder of the landscape will include 10% openings occupied by grasses, forbs, and shrubs (VSS 1), 10% seedling-saplings (VSS 2), 20% young forest (VSS 3), and 20% mid-aged forest (VSS 4). Within each VSS class is a ± 3% margin, i.e., post-harvest treatments can equal 17% VSS 5 and 23% VSS 6. This can be the difference between active management and focusing management efforts elsewhere. These structural stages are dynamic, growing from one stage to another and creating patches of mature trees that are available across the landscape through space and time. In addition, legacy trees are left on each acre of goshawk habitat that will not be harvested and instead are left to grow, die, and provide snags and logs.

Snag retention is another important habitat component for the northern goshawk because of the role they play in providing habitat for prey species. The Kaibab Forest Plan prescribes leaving snags in all three forested habitats including ponderosa pine, mixed conifer, and spruce-fir habitat types to support goshawk prey species (KNF Forest Plan 1996). The Forest Plan prescribes the goshawk guidelines to all forest and woodland habitat on the KNF, with the exception of Mexican spotted owl protected, restricted, and designated critical habitat, all of which have their own guidelines that take precedence (USFWS 1995).

Managed fires can create one to many acre patches of high-severity burns as tree canopies ignite. Fire can also reduce tree density, creating more open crowns. These openings can benefit many prey species (e.g., chipmunks, ground squirrels) while having mixed results for other species (tree squirrels). When managed fire is reintroduced into the ecosystem, snags and down logs will be reduced in the short term. They do provide immediate snag habitat and aid in

replenishing downed woody debris. Snags are also created indirectly when trees weakened by fire eventually succumb to insects and disease. Weakened trees may last for years before becoming snags and many of these processes create longer lasting snags.

Given forest conditions and current fire behavior, goshawk habitat is not sustainable without active management. Past fires maintained forests with repeated, low-intensity ground fire. Snag and downed log resources under frequent fire return intervals would probably be considered limited by today's standards. Today fires commonly are assessed for opportunities to allow them to continue to burn, but suppression is common to prevent stand replacing, high-severity crown fires. Prescribed fire, wildland fire use fires, and mechanical treatments are used to eventually attain sustainable forests. The goshawk food web approach, modeled using a 1,000-year time horizon, has strong parallels with the recommendations coming from forest restoration research through the Ecosystem Restoration Institute at Northern Arizona University (https://library.eri.nau.edu:8443/).

Population data:

BBS data (Sauer et al., 2005) for Arizona from 1966-2005 show a significant, positive population trend of 13 percent per year ($p = 0.03$; Fig. 2), but across the Southern Rockies, goshawks show a non-significant trend ($p = 0.690$). Both data analyses are from small data sets which exhibit several deficiencies, including low abundance (less than 1.0 bird/route), low sample size (less than 14 routes), imprecision (3%-year change would not be detected over the long term), and possible inconsistency in trend over time (sub-interval trends were significantly different [$P< 0.05$] from each other) (Sauer et al. 1999). Thus interpretation should be made with extreme caution and only used in light of surveys directly from the area of interest.

Additionally, NatureServe globally ranks goshawks as G5, meaning their numbers greatly exceed 10,000 individuals and are demonstrably widespread, abundant, and secure. Nationally, they are classified as N4, or greater than 10,000 individuals with apparently secure populations. However, goshawks are considered vulnerable to extirpation or extinction in Arizona with a total estimated population between 3,000 and 10,000 birds.

Locally, the majority of the KNF goshawk population occurs within the North Kaibab Ranger District on the Kaibab Plateau, where surveys and studies have been conducted for close to 2

decades. The most intensive study has been conducted by the Rocky Mountain Research Station (RMRS), a sub-branch of the Forest Service. The Kaibab Plateau goshawk project started in 1991 and is expected to conclude at the end of the 2008 field season. In addition, all ponderosa pine and ponderosa pine/Gambel oak habitat on the Forest was surveyed by USFS personnel, following Forest Service Regional northern goshawks protocol. Although most of the NKRD appears to be at carrying capacity, goshawk reproduction on the Kaibab Plateau has been highly variable over 15 years and overall showed a significant decline from 1991 to 2005, including the portions of the Plateau that have been managed by the National Park Service since the inception of the Grand Canyon National Park (Fig. 3, Reynolds 2005). Causes being investigated for the decline include change in forest composition and structure resulting from intensive forest management between the 1960s and early 1990s (large seed tree cuts) combined with catastrophic fire and wind throw, and natural environmental variation in prey abundance. Research to date indicates that as the amount of habitat changed by intensive management, fire, and wind-throw within goshawk territories increased, the frequency of reproduction decreased (Reynolds et al. 2006). Additionally, Salafsky et al. (2005) suggest that inter-annual fluctuations in precipitation and conifer seed production are correlated with, and may be responsible for, variation in prey abundance which in turn is strongly associated with goshawk reproduction. Together this suggests that goshawk demography is a complex interaction between vegetation composition and structure and natural variation in goshawk food resources, all of which may be confounded by ongoing drought conditions.

Swamping of habitat effects by large variations in food abundance, combined with the periodicity of wet versus dry weather in the Southwest, suggest that identifying the cause-effect responses of goshawks to forest management can only be accomplished through long-term research (Reynolds et al. 2005). In the 2005 summary report, Reynolds reported that precipitation and cone crops were high in 2005, suggesting 2006 would be productive for goshawks. Further, if the year produced a breeding rate greater than 50%, the goshawk population trend would change from a 15-year decline to stable over the last 16 years. Indeed, the 2006 breeding rate was 53%. However, 2007 is looking to be a poor year with breeding productivity in the 7% range, which will again result in overall negative trend. Breeding adult survival is 0.75 or declining. Reynolds et al. (2006) reports that goshawk reproduction over the 16-year study is not sufficient to replace adult mortality on the Kaibab Plateau. However, there seem to be enough juveniles to replace adults, suggesting the Plateau acts as source *and* a sink

population. Given that the demographics appear influenced by precipitation patterns, it is difficult to judge if the population is stable or declining (Reynolds personal communication). It also appears that the goshawk pairs within the Grand Canyon National Park section of the Kaibab Plateau, which are also monitored as part of Reynolds ongoing research, have lower reproductive rates than those on the National Forest (Reynolds personal communication). There has been essentially no timber harvest or other forest structure management within this portion of the National Park.

Data for the rest of the Forest show a similar decline in occupied territories (Fig. 4). While a decline in territories does not translate directly into reproductive effort, it does indicate that the number of adults that could be breeding on the forest is decreasing and that this decrease would result in less offspring recruited into the population. Data should be interpreted cautiously as the number of nests with unknown occupancy does vary by year.

Trend Estimate:

Considering the information above, northern goshawks are assumed to be declining on the Kaibab National Forest. However, if future weather patterns produce good precipitation, the population could stabilize. Only precipitation can fuel forest productivity in terms of abundant seed crops which result in prey population increases that occur at greater frequencies. Continued reduction of forest stem density and basal area should ameliorate the stochastic nature of weather by reducing the threat of large-scale, high-severity crown fire, thereby helping stabilize the population. Continued monitoring of the population and its response to forest treatments need to continue to be measured over the long term.